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ABSTRACT

To investigate task performance and the use of private speech and to examine the effects of a cognitive training approach, 30 learning disabled (LD) and 30 nonLD Ss (7 to 8 years old) were given a 17 piece wooden puzzle rigged so that it could not be completed correctly. Six variables were measured: (1) proportion of private speech that was task relevant; (2) proportion of private speech that was task irrelevant; (3) rate of private speech; (4) number of strategies used; (5) time on task before reaching the rigged piece; and (6) persistence time. Three significant differences were found between LD and nonLD Ss: LD Ss had a significantly lower proportion of task relevant utterances; time on task before reaching the rigged piece was significantly longer for LD Ss; and normally achieving Ss had significantly longer persistence times. Ss in the cognitive training group (who had watched a videotape of a young boy completing the task and learned to think out loud) had significantly higher proportion of private speech and task relevant private speech, used significantly more strategies, and had significantly longer persistence times. (Author/CL)

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The Effects of Cognitive Training on Private Speech and Task Performance During Problem Solving Among Learning Disabled and Normally Achieving Children

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Paper presented at the annual meeting of the American Educational Research Association

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Abstract

Theory and research with normally achieving children indicate that private speech can perform a cognitive self-guidance function. Research indicates that learning disabled (LD) children are deficient in the production of task-relevant strategies and may be deficient in the production of task relevant private speech. Cognitive training has been shown to be an effective method of improving task performance. Thus, this study had two purposes: first, to investigate task performance and the use of private speech among LD and normally achieving children in a problem solving situation; and secondly, to determine the effects of a cognitive training approach on task performance and the use of private speech.

The task used in this study was a 17 piece wooden puzzle rigged so that it could not be completed correctly. Subjects were 30 LD and 30 normally achieving children ages 7-0 to 8-11. The two independent variables were subject type and treatment condition (cognitive training and control). The six dependent variables were: (a) proportion of private speech that was task-relevant, (b) proportion of private speech that was task-irrelevant, (c) rate of private speech, (d) number of strategies used, (e) time on task before reaching the rigged piece, and (f) persistence time. Variable (b) was not entered into data analyses as it is an ipsative variable perfectly correleated with variable (a).

One LD subject and six normally achieving subjects in the control group did not engage in spontaneous private speech; this created an unbalanced design for the private speech measures. Thus, the dependent variables were broken into two groups for data analysis: private speech (variables a and c) and task performance (variables d, e, and f). Multivariate analyses of variance using the Wilks' lambda test of significance at the $p < .05$ level were used to analyze the two data sets. In both analyses, the multivariate F ratios for the interaction effects were not significant; the multivariate F ratios for subject type and treatment condition were both significant. The subsequent ANOVAs indicated that three significant differences existed between LD and normally achieving subjects: (a) LD subjects had a significantly lower proportion of task-relevant utterances, (b) time on task before reaching the rigged piece was significantly longer for LD subjects, and (c) normally achieving subjects had significantly longer persistence times. Four significant differences existed between the cognitive training and control groups: (a) the proportion of private speech that was task-relevant was significantly higher among subjects in the cognitive training group, (b) subjects in the cognitive training group had a significantly higher rate of private speech, (c) subjects in the cognitive training group used significantly more strategies, and (d) subjects in the cognitive training group had significantly longer persistence times. Implications and recommendations for future research were discussed in three areas: subjects, task and setting, and cognitive training.

Theory and research with normal children indicate that private speech can perform a cognitive self-guidance function (Luria, 1959, 196la; Meichenbaum & J. Goodman, 1971; Zivin, 1979). In addition, researchers have found that children who engage in a high proportion of task-relevant private speech perform more successfully in a task or problem solving situation (Fuson, 1979). The term private speech, as used in this study, refers to that subset of acommunicative speech which is self-regulating. A. Harris (1979) defines such verbal regulation as "the process through which some component of the language system monitors, controls, organizes, structures, or plans behavior arising in some nonverbal system in the individual" (p. 51).

While no research has focused directly on the nature of private speech among learning disabled (LD) children, existing theory and evidence indicate that LD children are deficient in the production of task-relevant strategies and may be deficient in the production of task-relevant private speech. Learning disabled children may exhibit a combination of, or all of, the following characteristics: an inactive disposition, learned helplessness, production deficiencies, developmental delay, and impulsivity (Flavell, Beach, & Chinsky, 1966; Kauffman & Hallahan, 1980; Thomas, 1979; Torgesen, 1977). These characteristics, alone or in combination, may affect both task performance and the production of task-relevant private speech. Moreover, LD children may produce negative, nonfacilitative self-statements as well as off-task-self-statements which further impede performance.

The development of cognitive training techniques has been strongly influenced by postulated relationships between private speech, thought, and behavior (K. Harris, 198la; K. Harris & Brown, in press; Meichenbaum & S. Goodman, 1979). Meichenbaum (1976) has suggested that learning problems may be due, in large part, to the child's use of non-functional or poorly organized

cognitive processes. Research with both LD and normally achieving subjects indicates that cognitive training can significantly improve performance in a variety of areas (Abikoff, 1979; Pressley, 1979). Thus, the purpose of this study was twofold: first, to investigate task performance and the spontaneous occurrence of private speech among LD and normally achieving children in a problem solving situation, and secondly, to determine the effects of a cognitive training approach on task performance and private speech during problem solving.

Review of Theory and Research

Further understanding of the nature of private speech is helpful in introducing the variables chosen for study in the present investigation. Therefore, a brief review of relevant theories of private speech, followed by a review of related studies involving LD subjects, is presented next.

Private Speech

Vygotsky (1934/1962) was the first researcher to explore the cognitive-developmental functions of private speech. Vygotsky presented a theory of the development of human intellect and thought in which the development and internalization of private speech played a central role. He emphasized the self-regulatory, planning function of private speech and saw such speech as serving the cognitive functions of orienting, organizing, and structuring behavior. To Vygotsky, children used private speech to consciously understand or focus on a problem or situation and to overcome difficulties. Thus, Vygotsky postulated that private speech would increase in task situations of increasing difficulty. After a series of experiments he reported finding a positive relationship between amount of private speech and task difficulty (Vygotsky, 1934/1962; Vygotsky & Luria, 1930). He also proposed that private speech follows a curvilinear developmental pattern, increasing with age until

internalization begins. Based on his research, Vygotsky (1934/1962, 1978) reported that private speech increases until the age of 6 or 7, declining and virtually disappearing by age 8-10. However, private speech can occur overtly at any age, whenever the individual encounters obstacles or problems.

Following Vygotsky's early death (cf. Wertsch, 1979), his former student, Luria, continued to develop a theory of self-regulation. However, the focus and direction of Luria's work was different than that of Vygotsky's. While Vygotsky theorized about and studied naturally occurring, spontaneous private speech and then made inferences to inner speech, Luria studied only induced, experimenter directed speech in laboratory settings (Zivin, 1979). Luria's research focused on the ability to condition, elicit, or inhibit behavior through the "impulse" or physical/motor stimulation of words (1957, 1959, 1960, 1961a, 1961b, 1969). Luria (1961a) proposed three stages in the development of verbal control over nonverbal motor behavior. In the first stage, the speech of others controls and directs the child's behavior to some extent, while the child's own speech is ineffective in controlling her/his behavior. The motor aspect of a child's overt private speech can initiate but cannot inhibit behavior in the second stage. In the third stage, the child's ability to use private speech for self-regulation continues to develop. During this stage, the semantic content of the child's private speech, overt or covert, is able to initiate, control, direct and inhibit behavior.

Luria's belief in the ability of language to regulate (through neurophysiological relationships) voluntary behavior, led him to hypothesize that language could intervene in the development or maintenance of behavior in organisms that were immature, damaged, or dysfunctional (A. Harris, 1979). His research with children with a cerebroasthenic syndrome (similar to hyperactivity) and adults evidencing Parkinson's disease indicated that verbal

signals could be used to gain some control over erratic motor responses (Luria, 1932, 1967). It should be noted that Luria's theory of the development of private speech and its rehabilitative functions has had a direct and significant influence on Western theories of cognitive behavior modification and cognitive training.

Western research. Western researchers have investigated the occurrence of verbalizations and their ability to mediate behavior under the labels "mediational deficiency" and "production deficiency" (Kendler, Kendler, & Wells, 1960; Kuenne, 1946; Maccoby, 1964; Reese, 1962). Especially relevant to the present investigation are studies conducted by Flavell and his colleagues. Based on their research, Flavell, Beach, and Chinsky (1966) discussed both linguistic immaturity and a general cognitive immaturity as possible explanations of production deficiency (failure to produce relevant verbalizations). The linguistically immature child may "have" a language and not yet know exactly when and where to use what he has. General cognitive immaturity may be seen as a tendency to act in an intellectually passive--rather than active--fashion. The authors described the intellectually active child as one who uses self-generated cognitive strategies, is able to sustain attention in the absence of both perceptual and social support, systematically plans for coping effectively with task requirements, and is goal-directed. They also noted that these characteristics may be beyond the intellectual capabilities of very young children, at least within the verbal coding and rehearsal task used in their research.

Keeney, Cannizzo, and Flavell (1967) noted the possible power of the production deficiency concept in explaining not only verbal mediation deficiencies, but also any problem "including the invocation and utilization of already-developed skills as means to some goal" (p. 965). Their study

indicated that production deficiencies occur among students who have the intellectual capabilities and components required for a task.

These studies helped to frame the "inactive learner" concept which has been applied to LD students by Torgesen (1977). Clearly, the current conception of the "inactive learner" reflects Keeney, Cannizzo, and Flavell's (1967) description and explanation of subjects evidencing a production deficiency:

> . . . He may have virtually everything his producing age mate has, save for a hard-to-conceptualize indisposition to spontaneously invoke this 'everything' in the here and now task setting . . . a child <u>can</u> be surprisingly ripe for production, from the standpoint of having all the obvious componentry, and yet remain for some period of his childhood a stable nonproducer--perhaps even a relatively incorrigible one . . . for any given problem and any given S there could be a longer or shorter period in S's childhood when the component means (verbal or nonverbal) are well developed in themselves and yet tend not to get spontaneously recruited and integrated into the problem-solving sequence (p. 965).

Thus, investigations of private speech may help in establishing and clarifying the existence of production deficiencies among the learning disabled.

<u>Research with the Learning Disabled</u>

The performance of LD subjects on tasks similar to ones used by Luria was investigated in one study (Dykman, Walls, Suzuki, Ackerman, & Peters, 1970). However, private speech was neither measured nor analyzed directly in this investigation. LD and normally achieving subjects ages 8 to 11 were trained on tasks involving responding correctly to the presentation of colored lights and sounds. The authors reported that LD subjects as a group made significantly more errors during these tasks and took longer to react than normals. The authors interpreted their data as indicating that LD subjects exhibit a slower processing of information in the central nervous system and related their findings to the private speech literature. However, two problems should be noted before considering the authors' further conclusions. First, LD subjects

were assigned to three groups: hyperactives, hypoactives, and normoactives. Both the reliability and validity of assigning these subjects to three different groups appears questionable (cf. K. Harris, 1981b). Further, both the chronological and mental ages of the normal subjects were 1 to 2 years greater than those of the majority of the LD subjects. Thus, it appears highly likely that many of the authors' significant differences, including comparisons between the LD groups, are at least partially reflective of age differences.

In spite of these methodological problems, this study (Dykman et al., 1970) did focus attention on Luria's hypotheses concerning private speech, the dysfunction of normal inhibitory processes, and possible relationships to learning disabilities. Drawing on data from previous studies, the authors postulated a defect in the cortical inhibitory and arousal networks among LD subjects and assumed that these networks are primarily under the control of language mechanisms. The authors discussed the role of private speech, both overt and covert, in the processing of information and the regulation of behavior. They noted that the importance of "inner speech" could be shown if inner speech training was found to decrease impulsivity, reaction time, or distractability. It should be noted that a growing body of research indicating the efficacy of cognitive training and self-verbalizations in reducing impulsive responding and error rates now exists (Abikoff, 1979; Pressley, 1979).

Studies in two other areas also helped to provide indirect evidence that LD students may be deficient in the production of task-relevant private speech. Havertape and Kass (1978) asked LD and normally achieving subjects to "think outloud" into a tape recorder during four types of problem solving tasks as a part of their data collection procedures. LD subjects were found to be significantly less proficient at problem solving. In addition, the authors'

recordings indicated that LD subjects had difficulty developing and applying attack strategies. Research on selective attention and memory has provided some evidence that LD subjects are deficient in verbal rehearsal, one form of private speech (Bauer, 1977; Haines & Torgesen, 1979; Hallahan, Tarver, Kauffman, & Graybeal, 1978; Mercer, Cullinan, Hallahan, & LaFleur, 1975; Schwartz & Bryan, 1971; Tarver, Hallahan, Kauffman, & Ball, 1976).

The present investigation is the first to focus directly on the use of private speech by LD children in a problem-solving situation. Comparing the production of private speech among LD and normally achieving children may help us to further understand deficits in the LD child's performance. If the LD child does not spontaneously produce or use private speech effectively, important implications for educational procedures may be suggested. Further, this study investigated not only the effect of cognitive training on task performance, but also the effects of cognitive training on private speech.

Method

Subjects

Subjects were 30 LD and 30 normally achieving students ages 7-0 to 8-11. Mean ages for the LD and normally achieving subjects were 8.06 and 8.00, respectively. Due to the 2-year range in ages, subjects were matched by age before being randomly assigned to the cognitive training and control groups. Sex of subject was not controlled, as previous research indicated that this was not necessary (Kohlberg, Yeager, & Hjertholm, 1968). All 60 subjects were chosen from elementary schools serving predominantly suburban, middle-class neighborhoods.

LD. Subjects identified as LD had to meet the following criteria: identification as learning disabled by their local system (using Indiana's eligibility requirements for services), an IQ score between 85-115, and

achievement at least one year below grade/age level in one or more academic areas. LD subjects were drawn from four different counties in the state. The public school systems would not allow administration of individual intelligence measures as a part of this study; therefore, IQ and achievement data were collected from school files. In addition, the experimenter met individually with each subject's special education teacher to insure that students with multiple handicaps or motor involvement (i.e. cerebral palsy) were not included. IQ scores came from the following instruments (administered within two years of data collection): Weschler Intelligence Scale for Children, Stanford-Binet, McCarthy Scales of Childrens Abilities. Mean IQ score for the cognitive training group was 96.06 (SD = 9.42, Range = 85-114). Mean IQ score for the control group was 97.80 (SD = 7.57, Range = 85-109). The cognitive training group contained 13 males and 2 females, the control group 9 males and 6 females.

Normally achieving. Sixty normally achieving subjects attending one large elementary school returned permission to participate in this investigation. However, research has indicated that private speech follows a different developmental trend among bright normals as compared to average normals (Kohlberg, Yeager, & Hjertholm, 1968). Thus, recent achievement scores on the Science Research Association Assessment Survey, Iowa Achievement Test, or Metropolitan Readiness Test were reviewed (intelligence tests could not be given). Subjects whose scores indicated achievement either 1 year or more below grade level or more than 1 1/2 years above grade level were eliminated. Subjects were randomly selected until 30 who met the above criteria were identified. The cognitive training group contained 9 males and 6 females; the control group 8 males and 7 females.

PPVT scores. In order to provide further descriptive information on the subjects selected, the Peabody Picture Vocabulary Test (PPVT) was administered to all subjects during data collection procedures. Means, standard deviations, and ranges for the estimated deviation IQ scores provided by the PPVT are presented in Table 1; scores were highly similar among all four groups.

Insert Table 1 about here

Pilot Work

Before this study could be conducted, a task had to be selected. Several criteria were considered in selecting the task. First, the task was to be one that involved problem solving. Havertape and Kass (1978) have provided the following definition, "problem solving refers to the efforts expended on reaching a goal and includes creative thinking, deductive reasoning, and judgement" (p. 94). Second, the task needed to be within the cognitive capabilities of 7 and 8 year olds, but had to include enough difficulty to stimulate overt self-speech. The last two criteria for selecting a task have been discussed by McKinney and Haskins (1980). They note that the task chosen for cognitive research should be one that allows the investigator to describe, as accurately as possible, the techniques competent individuals use to solve the problem at hand. Further, the task should allow direct measurement of the strategy behavior while the child is engaged in problem solving.

Puzzles meet these criteria. In addition, several researchers have successfully used puzzles in investigations of private speech (Fuson, 1979; Klein, 1964; Kohlberg et al., 1968). Therefore, a puzzle task was developed for use in this study and was modeled after Klein's (1964) example. Klein introduced an unexpected difficulty during a puzzle task by rigging a major

piece, making it impossible to fit correctly with the rest of the pieces. The rigged piece was re-cut from plywood, made slightly larger or more angular than the original, and painted to look the same as its original counterpart. The same procedure was followed in this study.

Pilot work was done with five normally achieving children, ages 7 and 8, in order to select an appropriate puzzle. Each pilot subject was watched carefully as they worked on several different puzzles to determine observable strategies, and answered several open-ended questions after each puzzle was completed. Playskool's wooden puzzle "Shazam" (#380-03, 17 pieces) was chosen for use in the present study. The Shazam puzzle depicts a superhero "flying" away and a young boy looking up and waving. The word Shazam (in 3 pieces) is at the top. This puzzle was chosen for several reasons: subjects reported it to be the most difficult (all pilot subjects were able to complete this puzzle correctly), it took the longest to complete (approximately 7-8 minutes), and this puzzle had the highest number of observable strategies. Interviews with the pilot subjects indicated additional strategies which were used and reportable. These 9 observable and reportable strategies, which were scored for all subjects in this study, are presented in Table 2. Before data collection began, a large, pink piece to the right of the superhero was re-cut and painted to match the original.

Insert Table 2 about here

Cognitive Training

The cognitive training approach used in this study was adapted from Meichenbaum's self-instructional regimen (Meichenbaum, 1977; Meichenbaum & J. Goodman, 1969, 1971). Meichenbaum's regimen consists of four steps: 1)

Cognitive Modeling--the adult model performs a task while talking aloud, the child observes; 2) Overt Guidance--the child performs the task using the same verbalizations, assisted by the adult at first, then alone; 3) Faded Self-Guidance--the child whispers the instructions while going through the task; and 4) Covert Self-Instruction--the child performs the task, guided by covert self-speech (Meichenbaum & S. Goodman, 1979). However, in the present study a videotaped model was used rather than a live model, and only overt verbalizations were modeled and required. Following Meichenbaum's lead, statements made by the model were aimed at possible deficiencies in comprehension, production, and mediation. Four types of statements were made: problem definition, strategy (including focusing of attention and response guidance), self-reinforcement, and self-evaluative (including error-correcting and coping statements). Strategies modeled included all of those listed in Table 2. Examples of the model's statements are: "I need to take my time and look at all the pieces before I start . . . What is this puzzle supposed to be? I have to figure that out . . . There's a circle shape down here at the bottom, I'll look for a circle piece . . . It fits! Good! . . . This is a hard one. Nope, not there. I won't quit. Keep trying, I'll get it." The modeled demonstration included coping with difficult pieces and self-correction of errors. The model was a 9 1/2 year old attractive, competent male. The videotape was black-and-white and was 6 minutes long.

The cognitive training approach did not consist of just watching the videotape. Several steps were followed, including focusing of attention on what was to be seen and heard, assessing what the subject had learned from the first time the tape was observed, further instruction, and watching the videotape a second time. All of the strategies used by the model and the different types of statements made were pointed out during training. The fact

that the model did not quit when difficult pieces were encountered, and the corresponding verbalizations, were also noted. When subjects began work on their puzzle they were told to do all of the things the model had done to help him, and to think outloud. One reminder to think outloud was given if a subject did not do so immediately after beginning the puzzle. Subjects did not see the puzzle in completed form before beginning; this made the task more difficult.

Data Collection Procedures

Both Fuson (1979) and Rubin (1979) have discussed the impact of setting in investigations of private speech. Natural or familiar settings may elicit more speech, while laboratory settings may allow for more sophisticated data collection techniques. Setting in this study was dictated by the large number of subjects and the fact that many subjects were nearly 100 miles away from the university. The subjects in this study met individually with the investigator in a small, quiet room at their own schools.

The experimental room was set up so that a sensitive, stand-up Sony microphone (ECM-18N) was hidden approximately 2 feet from the child's work space. The microphone was hidden behind pieces of typing paper taped to a large box (containing several puzzles) sitting on the table where the subject worked. A Hitachi cassette tape recorder (TRQ-33) was inside the box. None of the subjects ever became aware of the microphone or the taperecorder; the sound quality of this system was quite good. The room was also set up so that the investigator could sit several feet behind and to the side of the subject while he/she was working. The videotape was shown on a television set with at least a 20 in screen, to insure that subjects could see what the model was doing clearly.

The investigator spent the first 5-10 minutes talking with each subject and establishing a "cover story." Subjects were told that they were helping the investigator learn how good workers did several different things, so that the investigator could help younger children learn to do a good job. This cover story helped to relieve apprehension and anxiety (private speech can be inhibited if a subject is not comfortable) and to increase motivation. The first thing each subject was asked to do was draw a person. The investigator mentioned that she had some of her own work to do while the subject worked. By the age of 7 or 8, private speech may be inhibited in the presence of an "other," especially one who is monitoring performance (Fuson, 1979; Rubin, 1979). Thus, it was necessary for the investigator to appear busy and not obviously watching the subject. Once the necessary materials were given to the subject, the investigator went to her seat and appeared busy with paperwork. This same procedure was followed for the puzzle task.

After discussing the completed drawing, subjects in the cognitive training group went through the four cognitive training steps explained previously. Subjects in the control group went on to the puzzle task. At this point the tape recorder was turned on and the investigator went back to her seat, which allowed a clear view of the puzzle board and pieces. While the subject worked on the puzzle, each observable strategy was scored as either occurring or not occurring. The puzzle task was terminated when a subject either sat still, not looking at the puzzle or handling the pieces for 30 seconds, or when the subject turned around and told the experimenter that he/she was done or could not finish the puzzle. Many children could be expected to feel anxious or frustrated at this point. To alleviate this, the investigator looked in the box, came up with the correct piece, and then apologized for mixing up the puzzle pieces. Each subject was interviewed next using a pre-set list of

open-ended questions; this interview was also tape-recorded (cf. K. Harris, 1981b). The subject was asked about what he/she was thinking while working, what helped put the puzzle together, and what he/she would tell a 5 or 6 year old who was working on a puzzle. The four reportable strategies were scored from this interview. Lastly, each subject completed the Peabody Picture Vocabulary Test.

Meichenbaum and S. Goodman (1979) indicated the importance of transcribing verbalizations as soon as possible. Thus, all tapes were transcribed the same day. However, none of the transcriptions were scored for private speech until after all of the data had been collected. All transcriptions were scored "blind" as to subject type and treatment condition.

Dependent Measures

Six measures were collected for each subject. Three of these were measures of private speech: proportion of private speech that was task-relevant, proportion of private speech that was task-irrelevant, and rate of private speech. The last three measures were related to task performance: number of strategies used, time on task before reaching the rigged piece, and persistence time. The private speech measures are discussed first.

Meichenbaum and S. Goodman (1979) noted the importance of specifying "what constitutes a unit of private speech and the degree of reliability with which judges are able to agree on the number of units in a sample" (p. 329). They provided guidelines used for identifying a unit of private speech in their research with children doing puzzles. The same guidelines were followed in the present study (Meichenbaum & S. Goodman, 1979):

1. A speech unit generally defined by natural phrasing and sentence structure. Any phrase or sentence comprises one unit, subject to the second criterion, below. Nonsentences and nonphrases are also utilized by the second guideline.

2. An analysis of the pauses indicated that a two-second criterion could be employed to further unitize verbalizations. If a two-second or longer pause occurred between verbalizations then they were designated as separate units, irrespective of sentence structure (p. 329).

In order to determine the reliability of identifying units of private speech in the present study, a second investigator scored 15% of the tape recorded sessions (or tapes from nine subjects, including over 260 private speech units). The Pearson product-moment correlation coefficient was .98.

When an experimenter is present in the room, as was the case in the present study, it is also necessary to distinguish social speech from private speech. Meichenbaum and S. Goodman (1979) noted that differentiating between private speech and social speech is easier when the experimenter sits outside of the direct gaze of the child and is occupied with other work; this procedure was followed in the present study. Further, units of social speech were identified using Meichenbaum and S. Goodman's (1979) criteria: "(1) the child's looking at the experimenter and/or making eye contact; (2) a verbalization by the child that made reference to the experimenter in the context of the statement; (3) a repetition of the statement when no response was offered by the examiner" (p. 335). Instances of social speech occurred infrequently in the present study and were easily distinguishable from private speech using these criteria. Social speech units were not included in the data analysis for the present study, nor were unfinished sentences or phrases, incomprehensible mutterings, or lip movements. Only audible and comprehensible units of private speech were further categorized for data analysis.

Task-relevant private speech. Based on category systems presented by Beaudichon (1973), Klein (1964), Meichenbaum and S. Goodman (1979), and Rubin (1979), operational definitions of task-relevant private speech and task-irrelevant private speech were developed for use in the present study.

Task-relevant private speech includes regulatory statements that help plan, guide, or monitor behavior, while task-irrelevant private speech includes nonregulatory and off-task utterances. Task-relevant private speech was defined as: (a) analytic statements, where the child is reasoning about the task or what is required to carry it out ("I think it's a super-hero.", "I need a head first."), (b) comments about materials, including labels, descriptions or statements about a particular puzzle piece ("This is a round piece.", "This is a tricky piece."), (c) comments about activity, what the subject is doing or will do next, etc. ("I'm putting this here.", "Look for a leg."), (d) directions to the self ("I need to go slow."), (e) task-related questions to the self and/or answers ("Maybe this goes here.", "Nope."), and (f) feedback, comments implying that an action was right or wrong, good or bad, and comments monitoring performance ("That's wrong.", "I got it.", "I can't get this piece to fit.").

Task-irrelevant private speech. Units of private speech were categorized as task-irrelevant if they were: (a) word play ("A dogie, dogie, dogie."), (b) story telling or fantasy ("Goin' on a trip to Idaho."), (c) descriptions of irrelevant stimuli ("That's a funny noise."), (d) general statements about puzzles ("Some puzzles are really tricky."), (e) affective statements, positive or negative evaluations of overall performance, the difficulty of the task, or general feelings ("This is an easy puzzle.", "Stupid puzzle.", "I like puzzles."), and (f) expletives, nonwords, and noise making ("Crimeny.", "Pheweee,", "Hmm.", "Ta-da.", "B-b-b."). Further examples are included in Appendix A.

Reliability. Meichenbaum and S. Goodman (1979) provided guidelines for determining the reliability of scoring private speech units. After training, a second investigator scored the private speech units from 16 randomly selected

subjects (this represented 25% of the private speech data). The 16 transcriptions included 380 private speech units. Pearson product-moment correlation coefficients for task-relevant private speech and task-irrelevant private speech were both .99. However, correlation coefficients may mask disagreements between judges (Meichembaum & S. Goodman, 1979). Thus, percent agreement between judges was also calculated. Percent agreement for task-relevant and task-irrelevant private speech was .99 and .97, respectively.

Proportions and rate of private speech. Proportions of private speech were defined for each subject as the number of private speech units categorized as task-relevant (or task-irrelevant) divided by the total number of private speech units for that subject. Rate of private speech was defined as the total number of private speech units (task-relevant plus task-irrelevant) divided by the total length of time (in minutes) spent on the task.

Number of strategies used. As explained previously, pilot work indicated five observable strategies and four reportable strategies that could be used in solving the puzzle (see Table 2). Each subject received a score from 0 to 9, indicating the total number of strategies observed by the experimenter and reported by the subject. The public schools would not allow videotaping. Thus, it was not possible to determine inter-rater reliability for the observable strategies. However, the same investigator worked with all 60 subjects; no problems were noted in scoring the five observable strategies. Reportable strategies were scored from a transcription of the post-task interview. A second investigator scored the reportable strategies for 16 randomly selected subjects. The Pearson product-moment correlation coefficient for reported strategies was .99.

Time on task before reaching the rigged piece. This measure was defined as the number of seconds a subject worked on the puzzle before quitting or

completing the puzzle except for the rigged piece. A hidden stopwatch was used to obtain this measure. Only two subjects (both learning disabled and in the control group) quite working on the puzzle before reaching the rigged piece.

Persistence time. This measure was defined as the number of seconds, as determined by a hidden stopwatch, a subject continued to work after completing all of the puzzle except the rigged piece. At this point subjects typically took several pieces (or all of the pieces) back out and tried rearranging them. Subjects in the cognitive training group had seen the model use this strategy when a piece wouldn't fit. The two subjects who quit working on the puzzle before reaching the rigged piece were assigned persistence scores of 0.

One other observation should be made at this point. Klein (1964) noted that about 1/2 of his subjects engaged in overt private speech during problem-solving. It is interesting to note that in the present study, similar to Klein's results, 9 of the 15 normally achieving subjects in the control group engaged in overt private speech. However, 14 of the 15 LD subjects in the control group engaged in overt private speech. Subjects in the cognitive training group were asked to use overt private speech; all of them did so.

Results

As noted previously, one LD subject and six normally achieving subjects in the control group did not engage in spontaneous private speech; this created an unbalanced design for the private speech measures. Thus, the dependent variables were broken into two groups for data analysis: private speech (proportion task relevant and rate; proportion task-irrelevant was not entered into data analyses as it is an ipsative variable perfectly correlated with proportion task relevant) and task performance (number of strategies used, time on task before reaching the rigged piece, and persistence time). Multivariate

analyses of variance using the Wilks' lambda test of significance at the $p < .05$ level were used to analyze the two data sets.

As can be seen in Tables 4 and 7, both multivariate F ratios for the interaction effects were not significant. The multivariate F ratios for subject type and treatment condition were significant in both analyses. As explained by Hummel and Sligo (1971), a significant multivariate F ratio must be obtained in the MANOVA in order to interpret the subsequent univariate analyses of variance. Thus, interaction effects in the subsequent univariate analyses are not interpreted. Main effects for both subject type and treatment condition can be discussed. The univariate analyses of variance for the two data sets are presented in Tables 5 and 8. Correlations among the two sets of dependent variables are presented in Tables 3 and 6. The means and standard deviations for the dependent measures are presented in Table 9.

Insert Tables 3,4,5,6,7,8 and 9 about here

As Tables 5 and 8 show, three significant differences existed between LD and normally achieving subjects: (A) LD subjects had a significantly lower proportion of task-relevant utterances, (b) time on task before reaching the rigged piece was significantly longer for LD subjects, and (c) normally achieving subjects had significantly longer persistence times. Four significant differences existed between the cognitive training and control groups: (a) the proportion of private speech that was task-relevant was significantly higher among subjects in the cognitive training group, (b) subjects in the cognitive training group had a significantly higher rate of private speech, (c) subjects in the cognitive training group used significantly

more strategies, and (d) subjects in the cognitive training group had significantly longer persistence times.

Discussion

Private Speech

Among the private speech measures (proportion task relevant and rate), one significant difference was found between LD and normally achieving subjects. Proportion of private speech that was task-relevant was significantly lower among LD subjects as compared to normally achieving subjects (and, thus, the proportion of private speech which was task-irrelevant was significantly higher among LD subjects). For the LD subjects, 49% of their overt, audible private speech was task-relevant; for the normally achieving subjects, 76% was task-relevant. Inspection of the cell means (see Table 9) indicates that the proportions of task-relevant private speech for LD and normally achieving subjects in the control condition were 29% and 67%, respectively. Proportions of task-relevant private speech for LD and normally achieving subjects in the cognitive training condition were 67% and 82%, respectively.

Inspection of the transcriptions indicated that task-irrelevant utterances were spread throughout the task and that the majority of the task-irrelevant utterances made by both LD and normally achieving subjects could be characterized as expletives and nonwords. However, 43% of the LD subjects, and only 13% of the normally achieving subjects, also made negative affective statements about their overall performance, the difficulty of the task, and puzzles in general. Utterances which could be characterized as positive affective statements, word play, and story telling/fantasy were rarely made. Rubin (1979) also found the majority of task-irrelevant utterances to consist of expletives and nonwords among the 7- to 11-year-old subjects in his study.

The fact that LD subjects produced a significantly higher proportion of

task-irrelevant private speech and the observation that LD subjects were more likely to make negative affective statements are especially interesting when the relatively low difficulty level of the task is considered. All 30 of the normally achieving subjects completed all of the puzzle that was possible. Of the 30 LD subjects, only two (both in the control group) did not complete all of the puzzle that was possible. Of these two subjects, on quit with only one piece other than the rigged piece left, while the other quit with six additional pieces left. Learning disabled children may produce a higher proportion of task-irrelevant private speech, even during a relatively easy task, for several reasons. Several researchers (Klein, 1964; Vygotsky, 1934/1962, 1978) have noted that some private speech may serve expressive or tension release functions and may be related to personality factors. A higher level of anxiety, tension, or frustration may have existed among the LD subjects. In addition, although the majority of the LD subjects completed all of the puzzle possible, the LD children may have been more likely to expect difficulty and failure (cf. Thomas, 1979; Wallace & McLoughlin, 1979). Roberts (1979) has investigated the relationship between competence and private speech. He reported that first-grade children who were less competent at a sentence completion task engaged in far more task-irrelevant private speech (including nonwords and fantasy) than their counterparts and also produced more negative evaluation statements.

Another possible contribution to the higher proportion of task-irrelevant private speech evidenced by LD subjects is suggested by observations made during the present study and by the results of Rubin's (1979) research. Rubin found that task-irrelevant speech was more likely to occur during nonconstructive or off-task behaviors (subjects were videotaped). In the present investigation, LD subjects may have been engaging in more off-task

behaviors than their normally achieving peers. The investigator's observations indicated that LD subjects, especially those in the control group, were less organized than their normally achieving peers and were more likely to engage in off-task behaviors such as staring into space, looking around the room, fidgeting, and attempting to initiate conversations with the investigator. Future studies where videotaping is possible should incorporate scores for on- and off-task behaviors and relate these behaviors to the occurrence of different types of private speech (Fuson, 1979; Meichenbaum & S. Goodman, 1979; Roberts, 1979; Rubin, 1979).

The higher proportion of task-irrelevant private speech might also be related to a lower level of maturity among the LD subjects. Evidence is accumulating that LD students exhibit developmental delays (Hallahan, Kauffman, & Ball, 1974; Pelham & Ross, 1977; Tarver, Hallahan, Cohen, & Kauffman, 1977; Tarver & Maggiore, 1979). In future studies, the inclusion of a group of normals approximately two years younger than LD subjects would facilitate investigation of a developmental delay in the use of private speech among LD children. In addition, the proportions of private speech that are task-relevant and task-irrelevant among LD and normally achieving children might vary among differing tasks and differing levels of difficulty. Thus, future investigations should incorporate different tasks and difficulty levels and investigate the relative effects of personality factors, need for tension release, off-task behaviors, and developmental delay on the occurrence of private speech among the learning disabled.

No significant difference was found between LD and normally achieving subjects in rate of private speech. The mean rates for LD and normally achieving children were 2.78 and 2.63 utterances per minute, respectively. If a developmental delay in the use of private speech does exist among LD

children, differences in rate and developmental trends should exist. As noted previously, all of the subjects in the cognitive training condition were asked to and did use overt private speech. However, this request was not made in the control condition; in the control group 9 of the 15 normally achieving subjects and 14 of the 15 LD subjects engaged in overt private speech. Rates of private speech for LD and normally achieving subjects in the control group were 1.26 and 1.02 utterances per minute, respectively. Researchers should investigate rate and the developmental trend of private speech across different tasks in future studies.

Further, subjects in the present study were not videotaped. Therefore, instances of lip movements and inaudible mutterings could not be reliably scored and were not included in computing rate of private speech. Several researchers (Klein, 1964; Kohlberg et al., 1968; Vygotsky, 1934/1962, 1978) have suggested that the occurrence of lip movements and inaudible mutterings indicate a higher level of development in the use of private speech. The investigator's notes during the present investigation indicated that inaudible mutterings and lip movements occurred more frequently among normally achieving subjects, especially those in the cognitive training group who were asked to "think outloud." Thus, future studies where videotaping is possible should compare scores for lip movements and inaudible mutterings among LD and normally achieving subjects.

Cognitive training significantly increased both the proportion of task-relevant private speech and the rate of private speech. Forty-four percent of the utterances made in the control group were task-relevant, whereas 74% of the utterances made in the cognitive training group were task-relevant. Subjects in the control group made 1.17 utterances per minute, whereas subjects in the cognitive training group made 3.89 utterances per minute. Thus, it can

be concluded that subjects in the cognitive training group were able to model the types of statements made during cognitive training and that watching and copying the model resulted in a higher proportion of task-relevant private speech. This is especially promising due to the relatively short amount of time spent in training (approximately 20-25 minutes).

As can be seen in Table 9, 29% of the private speech utterances made by LD subjects in the control group were task-relevant and 71% were task-irrelevant. For LD subjects in the cognitive training group, 67% of their private speech was task-relevant and 33% was task-irrelevant. In spite of the fact that LD subjects consistently produced a higher proportion of task-irrelevant private speech than normally achieving subjects, cognitive training did increase the proportion of their private speech that was task-relevant. Repeated training sessions and revisions of the cognitive training procedures might result in further improvements. Cognitive training approaches in future studies might incorporate the identification of task-irrelevant private speech and training subjects to inhibit such utterances. As noted previously, the occurrence of task-irrelevant private speech has been found to be correlated with the occurrence of nonconstructive or off-task behaviors (Rubin, 1979). Thus, the identification and inhibition of nonconstructive and off-task behaviors might also be incorporated in future cognitive training approaches. However, it should be remembered that some task-irrelevant private speech (such as expletives, nonwords, and affective statements) may serve positive functions such as tension release. Subjects could be taught appropriate, task-relevant utterances to keep them on task and to handle anxiety, frustration, and tension.

Task Performance

The three measures of task performance were: number of strategies used, time on task before reaching the rigged piece, and persistence time. Differences between LD and normally achieving subjects on these three variables are discussed next, followed by a comparison of the cognitive training and control conditions.

No significant difference between LD and normally achieving subjects was found in number of strategies used. Although a significant interaction effect for subject type by treatment condition was found for strategies, interpretation of this interaction is precluded due to the nonsignificant interaction effect in the MANOVA. However, this interaction indicates that use of strategies is a promising area of investigation for future studies.

Time on task before reaching the rigged piece was significantly longer for LD subjects. This measure was defined as the number of seconds it took a subject to complete all of the puzzle except the rigged piece or, in the case of the two LD subjects in the control group, before quitting. The scores on time on task before reaching the rigged piece for the two LD subjects who quit before completing all of the puzzle possible were comparable to scores among the other LD subjects. Thus, the scores for these two LD subjects did not contaminate this measure. If these two subjects had continued to work on the puzzle until completion their scores would have been higher, making the main effect more significant. Mean scores for LD and normally achieving subjects were 463.16 seconds and 342.66 seconds, respectively.

Two reasons for the significantly longer time on task before reaching the rigged piece among the LD subjects appear possible. First, it is possible that the LD subjects experienced more difficulty with the puzzle, although 28 of the 30 LD subjects completed all of the puzzle that could be completed. A more

likely possibility is that, as explained previously, the LD subjects may have been engaging in more off-task behaviors than their normally achieving peers. The fact that time on task before reaching the rigged piece continued to be longer for LD subjects even after cognitive training indicates that no improvement was found among LD subjects on this measure of task performance. Revising the cognitive training approach, as described previously, or using repeated training sessions may have more positive effects.

LD subjects scored significantly lower than normally achieving subjects on persistence time (defined as the number of seconds a subject continued to work after completing all of the puzzle except the rigged piece). The puzzle appeared solvable; the typical response upon completion of all of the puzzle except the rigged piece was to take out several, or all, of the puzzle pieces and try rearranging them. Mean persistence scores for LD and normally achieving subjects were 120.40 seconds and 182.13 seconds, respectively. This difference in persistence scores was expected. Both an inactive disposition and learned helplessness may be related to decreases in task persistence and deficits in task performance among LD children (Thomas, 1979; Torgesen, 1977).

Significant differences between the control and cognitive training groups were found for two of the task performance variables. Cognitive training significantly increased both the number of strategies used and persistence. Mean number of strategies used was 4.53 in the control group and 6.80 in the cognitive training group. Mean persistence time was 112.33 seconds in the control group and 190.20 seconds in the cognitive training group. It should be noted that while LD subjects had significantly lower persistence scores than normally achieving subjects, the cognitive training approach increased persistence scores for LD subjects from 96.53 seconds in the control group to 144.26 seconds in the cognitive training group.

The nonsignificant difference between the control and cognitive training groups in time on task before reaching the rigged piece is also interesting. Requiring students to use overt private speech ("think outloud") did not significantly increase the amount of time it took them to complete all of the puzzle except the rigged piece, although a slight increase did occur. Several researchers have noted that requiring overt private speech may interfere with or slow down task performance (Keogh & Glover, 1980; Meichenbaum, 1980; O'Leary, 1980. This was not the case in the present study.

Cognitive training appears to be a promising method of improving task performance (in terms of strategies used and persistence) for both LD and normally achieving children. However, cognitive training processes may interact with both task and person variables, including task length, complexity, cognitive processes required, and setting, as well as the individual's age, personality, cognitive maturity, and cognitive style (Keogh & Glover, 1980; Meichenbaum, 1980; O'Leary, 1980). Thus, great care must be exercised in designing a cognitive intervention for use in classroom or laboratory settings. A thorough task analysis of both the learner and the task must be done. Further, it should be remembered that the natural development of verbal regulation of behavior is a slow process keyed to developmental stages. Clinical and classroom cognitive training interventions might also require considerable time and consideration of developmental variables in order to assure generalizable and durable changes in behavior. As the training in this study was short-term and applied to only one task, generalizability and durability were neither expected nor tested; it is hoped that this study will help set the stage for future investigations of more intensive, long-term treatment approaches.

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Table 1

Estimated IQ Scores from the Peabody
Picture Vocabulary Test

Group		Subject Type: Learning Disabled	Subject Type: Normally Achieving
Cognitive Training	x	106.66	107.00
	SD	8.70	6.70
	Range	92-124	95-121
Control	x	106.60	108.60
	SD	9.53	8.41
	Range	91-123	95-128
Total	x	106.63	107.80
	SD	8.97	7.52
	Range	91-124	95-128

Table 2
Puzzle Solving Strategies

Observable Strategies:

1. Subject turns pieces color side up before beginning.
2. Subject turns pieces to correct orientation (i.e., body parts and letters are not upside down) before beginning.
3. Subject matches puzzle parts off board before placing them on the board at least once.
4. Subject puts together at least three body parts sequentially.
5. Subject puts the word Shazam together (correctly or incorrectly) before/as placing it on the board.

Reportable Strategies:

6. Subject reports matching by colors.
7. Subject reports matching by shapes.
8. Subject reports beginning the puzzle with the outside pieces.
9. Subject reports trying to figure out what the puzzle was going to be.

Table 3

Pearson Product-Moment Correlation Coefficients Among the Two Private Speech Variables

Dependent Variables:	Proportion Task-Relevant	Rate
Proportion Task-Relevant		.4912
Rate	.4912	

Table 4

MANOVA Summary Table: Effects of Interaction, Subject Type, and Treatment Condition on the Two Private Speech Variables

Source	df	F
Interaction	2,49	2.63
Subject Type	2,49	17.47*
Treatment Condition	2,49	20.54*

*$p < .000$

Table 5

ANOVA Summary Table
for the Two Private Speech Variables

Source	df	SS	F
	Proportion Task-Relevant		
Treatment	1	.89	13.25*
Subject Type	1	.88	13.10*
Interaction	1	.17	2.48
Error	49	3.29	
	Rate		
Treatment	1	95.98	24.20**
Subject Type	1	2.22	.56
Interaction	1	.39	.10
Error	49	194.38	

*$p < .001$

**$p < .0001$

Table 6

Pearson Product-Moment Correlation Coefficients Among the Three Task Performance Variables

Dependent Variables:	Strategies	Time Before Rigged
Persistence Time	.0137	-.1003
Time Before Rigged	-.1621	

Table 7

MANOVA Summary Table: Effects of Interaction, Subject Type, and Treatment Condition on the Three Task Performance Variables

Source	df	F
Interaction	3,56	7.29
Subject Type	3,56	9.49*
Treatment Condition	3,56	58.80**

*$p < .05$

**$p < .000$

Table 8

ANOVA Summary Table
for the Three Task Performance Variables

Source	df	SS	F
	Strategies Used		
Treatment	1	77.07	91.44***
Subject Type	1	1.67	1.98
Interaction	1	5.40	6.41*
Error	56	47.20	
Total	59	131.33	
	Time on Task Before Rigged		
Treatment	1	66733.35	1.70
Subject Type	1	217803.75	5.54*
Interaction	1	2954.02	.08
Error	56	2203779.46	
Total	59	2491270.58	
	Persistence Time		
Treatment	1	90948.27	7.94**
Subject Type	1	57165.07	4.99*
Interaction	1	13620.27	1.19
Error	56	641826.13	
Total	59	803559.73	

*$p < .05$

**$p < .01$

***$p < .0001$

Table 9

Means and Standard Deviations for Dependent Measures by Subject Type and Treatment Condition

Group	N		Proportion Task-Relevant	Rate[a]	N	Strategies	Time Before Rigged[b]	Persistence Time[c]
				By Cells				
LD in Cognitive Training	15	$\bar{X}$	.67	4.19	15	6.93	503.53	144.26
		SD	.28	2.93		1.16	230.85	109.21
LD in Control	14	$\bar{X}$	.29	1.26	15	4.06	422.80	96.53
		SD	.29	1.60		.79	254.65	100.10
Normal in Cognitive Training	15	$\bar{X}$	.82	3.60	15	6.66	369.00	236.13
		SD	.15	1.53		.72	130.98	135.57
Normal in Control	9	$\bar{X}$	.67	1.02	15	5.00	316.33	128.13
		SD	.30	1.02		.92	148.70	74.26
				By Main Effects				
LD	29	$\bar{X}$	.49	2.78	30	5.50	463.16	120.40
		SD	.34	2.77		1.75	242.32	105.75
Normal	24	$\bar{X}$	.76	2.63	30	5.83	342.66	182.13
		SD	.23	1.85		1.17	140.27	120.63
Cognitive Training	30	$\bar{X}$	.74	3.89	30	6.80	436.26	190.20
		SD	.24	2.31		.96	196.70	129.67
Control	23	$\bar{X}$	.44	1.17	30	4.53	369.56	112.33
		SD	.34	1.38		.97	211.92	88.07
				Total Group				
Total Group	53	$\bar{X}$	.61	2.71	60	5.66	402.91	151.26
		SD	.32	2.38		1.49	205.48	116.70

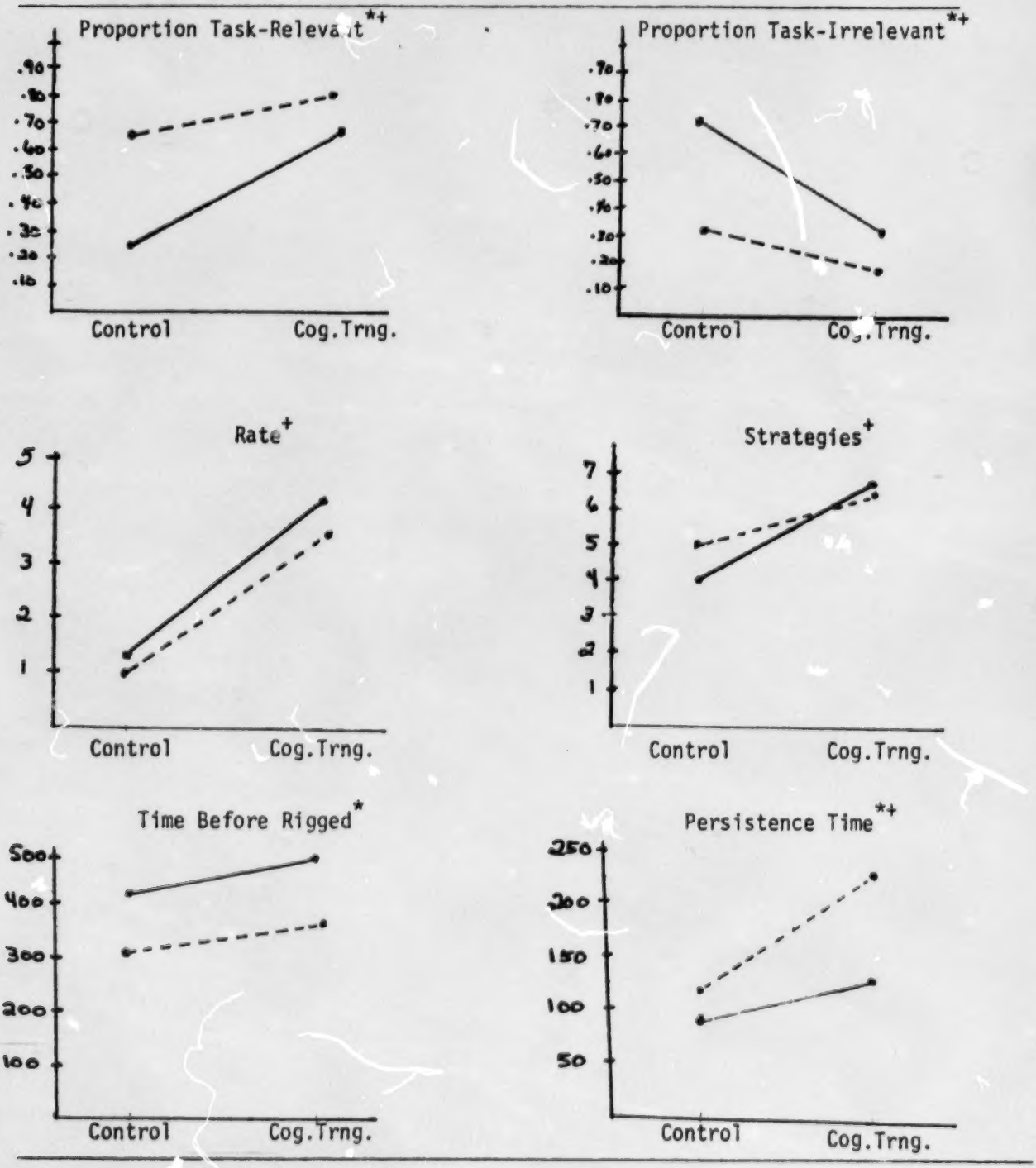
[a]Rate is total number of self-speech units divided by minutes.

[b]Time on task before the rigged piece is reported in seconds.

[c]Persistence time is reported in seconds.

Figure One

Graphs of the Mean Scores for Subject Type and Treatment Condition Among the Six Dependent Variables



*A significant difference exists between LD and normally achieving subjects.
+A significant difference exists between the control and cognitive training conditions.

APPENDIX A

Scoring Guidelines

Each utterance should be coded as one of the following two:

(TR) 1. Task Relevant includes:

	examples:
- analytic statements; figuring things out; what is needed, what needs to be done.	I think it's a super-hero. I need a head first. Maybe I put that in wrong.
- comments about materials; includes labels, descriptions, and comments about a piece.	This is a round piece. This is a tricky one. This is a hard piece.
- comments about activity (what S is doing or will do next, etc.) can include directions to self.	Look for a leg. I have to find - - -. I need to go slow.
- questions to self and/or answers.	Maybe this goes here. Nope.
- feedback - S implies that an action was right or wrong, good or bad. May include self-reinforcement or monitoring, as work is being done.	What could this be. That's wrong. Doesn't fit. I got it. I can't get this piece to fit. I'm done except this one piece. Looks like I'm done.

(T1) 2. Task Irrelevant

- word play.	A dogie, dogie, dogie.
- story telling/fantasy.	I'm going to brownies.
- talk about other activities.	Goin' on a trip to Idaho. I like swimming.
- descriptions of irrelevant stimuli.	That's a funny noise.
- general statements about puzzles.	Some puzzles are really easy, like the ones I have at home. Some puzzles are tricky.

- positive affective statements (positive evaluations of <u>overall performance</u> & about the difficulty of the task; also positive feeling statements.)	I'm good at puzzles. This is an easy puzzle. I like this.
- negative affective statements (negative evaluations of <u>overall performance</u> & about the difficulty of the task; also negative feeling statements.)	This is a stupid puzzle. Some of these pieces don't even fit. I'm no good at puzzles. This is hard. Hard puzzle. I don't like puzzles. I can't do this. I'm having trouble w/these pieces.
- expletives and nonwords (incidental verbal activity; sound play; exclamations; noise making).	Criminey; Phew; Well; Golly; Hmm; Ta da; B-B-B.